IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of
Martin KASPAR et al.
Corres. to PCT/EP2003/011692
For: COLLECTING TANK, HEAT EXCHANGER AND COOLANT CIRCUIT

VERIFICATION OF TRANSLATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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Collecting tank, heat exchanger and coolant circuit

The invention relates to a collecting tank having a drain plug, and to a heat exchanger and a coolant circuit.

Heat exchange media as in the coolant circuits of air conditioning systems, for example, are often led through collecting tanks thereby serving, on the one hand, to equalize the pressure, and on the other possibly ensuring the complete condensation of any refrigerant. In addition, a heat exchange medium in such a collecting tank may have particles removed by means of a filter device and any water removed by means of a drier device. In order to design such a filter and/or drier device so that it can be replaced for maintenance purposes, it is necessary to provide the collecting tank with a reversibly closeable aperture, through which the filter and/or drier device can be removed from the collecting tank.

A collecting tank of this type is described in DE 100 39 260 A1 of the present applicant. Inside, the collecting tank described accommodates a drier, which for maintenance purposes can be changed by way of an aperture that can be closed by a removable cover. The cover in this case takes the form of a cylindrical plug and is axially displaceable and sealed in a corresponding cylindrical bore of the collecting tank. In addition, this plug is fixed by a retainer ring, the retainer ring being secured to prevent its release by a locking offset bearing on the plug. The plug is at the same time pressed axially outwards against the retainer ring by an excess pressure acting on said plug, as is present inside the collecting tank during operation. To open, the plug must be pressed inwards when the collecting tank is unpressurized, so that the retainer

ring is released and can be removed, following which the plug can also be removed from the collecting tank.

The bore is sealed by way of two sealing rings, which are each arranged in an annular groove in the plug and are pressed into the annular grooves by introducing the plug into the collecting tank. In order to obtain an adequate sealing effect, the outside dimensions of the plug must on the one hand be matched precisely to the inside dimensions of the bore. On the other hand, the plug must be composed of the same material as the collecting tank, in order to prevent a diminishing sealing effect during operation of the collecting tank, since different materials are possibly subjected to different degrees of thermal expansion owing to the naturally occurring temperature fluctuations of the heat exchange medium. These restrictions on both the shape and the material of the plug have a disadvantageous impact on the manufacture of such a collecting tank.

Since the known collecting tank is composed of aluminum, the plug is also made of aluminum. The strength of this material means that it is possible to make the plug hollow, in order to save weight and material costs, without having to accept a reduction in the dimensional stability of the plug.

The object of the present invention is to provide a collecting tank, a heat exchanger and/or a coolant circuit, in which simplified and/or inexpensive manufacture and possibly an improved sealing effect can be achieved.

This object is achieved by a collecting tank having the features of claim 1, by a heat exchanger having the features of claim 9 and by a coolant circuit having the features of claim 10.

According to Claim 1 a collecting tank for a heat exchange medium comprises a housing, in which a drier and/or filter device can be accommodated. The housing is provided with an aperture, which can be closed by a removable plug and through which the drier and/or filter device can be received into and removed from the housing, so that the drier and/or filter device is of replaceable design. For this purpose the housing aperture can be closed by a removable plug and sealed by a sealing means. The sealing means may be one or more sealing rings, which is/are composed of an elastomer material such as rubber or Teflon.

The object of the invention is advantageously achieved in that the plug is elastically deformable. Whilst the collecting tank is in operation the plug can thereby be deformed by an internal pressure in such a way that the plug is pressed against an edge of the housing aperture by the sealing means. This ensures the desired sealing even when the plug, simply by virtue of its dimensions, would be incapable of exerting sufficient pressure on the sealing means, which may be the case, for example, due to an inaccurate production dimension or to different degrees of thermal expansion of the plug and the housing.

In the context of the invention the term elastically deformable plug is taken to mean a plug which due to the application of a pressure inside the collecting tank modifies its shape in such a way that the sealing means is subjected to a force. An ordinary operating pressure for heat exchange media such as refrigerant in air conditioning systems, for example, is already sufficient for this purpose. In this sense a solid aluminum plug, for example, possesses no elastic deformability.

The elastic deformability of the plug can be achieved on the one hand by a suitable plug geometry. The plug

has a recess, for example, with a thin wall in such a way that the wall can be pressed against an edge of the housing aperture by means of a pressurized heat exchange medium present inside the recess. The plug is preferably designed basically as a hollow cylinder with an open end towards the interior of the housing, the aperture having a circular cross-section. The heat exchange medium then presses the cylinder wall radially towards an edge of the aperture, with the result that the sealing means, preferably a sealing ring, is uniformly compressed, achieving an effective sealing action. The structure of the collecting tank is particularly simplified if the housing is designed as a tube having an open end. The aperture is then formed by the open tube end, into which the plug can be received.

On the other hand it is possible to manufacture the plug from an elastically deformable material. In this case also, the plug is pressed against an edge of the housing aperture by the pressure of the heat exchange medium, so that the sealing means is compressed in order to achieve an improved sealing effect.

A combination of a suitable plug geometry with the selection of an elastically deformable material is especially preferred. For example, a hollow-cylindrical plastic plug is particularly well-suited as removable closure for the collecting tank, since a plastic affording sufficient elasticity for a deformability according to the invention together with sufficient strength for closing the collecting tank makes it an automatic choice. In order to prevent the heat exchange medium permeating through the plug material, the plug preferably has a shielding element. The shielding element more preferably takes the form of a metalized coating or enameled coating, which is applied at least to the side of the plug facing the interior of the housing.

In a preferred embodiment the plug is integrally formed with the sealing means, the resulting reduction in the number of components serving to reduce the assembly cost of the collecting tank. In the case of a plastic plug in particular, the sealing means can be molded onto the plug with the result that an especially simple one-piece plug design with the sealing means can be achieved.

The plug is preferably secured to prevent it falling out of the collecting tank, being held in the aperture by a retainer ring. In particular, detachment of the retainer ring from any annular groove provided in the edge of the housing aperture is prevented by securing the retainer ring by means of a locking offset, which is provided on the plug and which bears on the inside edge of the retainer ring.

In an advantageous embodiment the collecting tank according to the invention is inserted into a heat exchanger, having tubes, fins and two head pieces, in such a way that a heat exchange medium flowing through the heat exchanger flows previously, subsequently or in the meantime through the collecting tank. In particular, the heat exchanger here takes the form of a condenser, a drier then most preferably being introduced into the collecting tank. Such heat exchangers have been disclosed in DE 42 38 853 C2, which hereby expressly forms part of the disclosure.

According to a further advantageous embodiment the collecting tank according to the invention is inserted into a coolant circuit of an air conditioning system having a compression element, a first heat exchanger, an expansion element and a second heat exchanger, in order to permit collecting of the refrigerant. The collecting tank here in particular contains a drier for the refrigerant. In particular the compression element

is in this case a compressor, the first heat exchanger is a condenser, the expansion element is an expansion valve and the second heat exchanger is an evaporator.

The invention will be explained in more detail below on the basis of exemplary embodiments and with reference to the drawings, in which

Fig. 1 shows a heat exchanger having a collecting tank according to the invention and

Fig. 2 shows a detail of a collecting tank in cross-section.

Fig. 1 represents a condenser (1) of a coolant circuit (otherwise not shown) for an air conditioning system. It has a tube-fin block (10) with tubes (11) and fins (12) arranged between these. The tubes (11), which in this exemplary embodiment take the form of flat tubes, open out into collecting pipes (13, 14) which extend on both sides over the entire height of the tube-fin block (10). A first collecting pipe (13) is provided with a feed connection (15) for a gaseous refrigerant coming from a compression element (not shown), such as a compressor, for example, and with an outlet connection (16) for liquid refrigerant flowing to an expansion element (likewise not shown), such as an expansion valve, for example.

The two collecting pipes (13, 14) are subdivided by dividing walls (17, 18, 19, 20), 21, 22, 26, 27) into head pieces (33, 24) communicating with the connections (15, 16) and into intermediate pieces (35, 36, 37, 38, 39, 40, 41, 42) in such a way that the refrigerant from the head piece (33) to the intermediate piece (40) and from the intermediate piece (42) to the head piece (34) in each case describes a serpentine path through the condenser (1), the flow cross-section being likewise reduced as cooling increases accordingly with the

diminishing volume of the gaseous and/or liquid refrigerant. The collecting pipes (13, 14) are sealed fluid-tight by end walls (28, 29, 30, 31).

Connected to the collecting pipe (14) is a collecting tank (43), which serves for collecting the condensed refrigerant. The housing (23) of the collecting tank (43) has an inlet aperture (24) and an outlet aperture (25), which communicate with the intermediate pieces (40) and (42) respectively of the collecting pipe (14). Inside the housing (23) is a drier and filter device (32), which can be removed from the housing (23). For this purpose the tubular housing (23) is closed at one end by a removable plug (44), so that the drier and filter device (32) can be replaced, for maintenance purposes, for example, via the aperture (45).

Fig. 2 shows a more detailed, cross-sectional view of part of a collecting tank (100) having a plug (110). The collecting tank comprises a round tubular shaped housing (120), one end (130) of which is open. The housing (120) has an inlet aperture (not visible) and an outlet aperture (140) for a heat exchange medium such as a refrigerant, for example. A connection to an adjoining collecting pipe (150) with dividing and end walls (160, 170) is made via an opening (180) in the collecting pipe (150), a raised edge (190) of the aperture (180) engaging in the outlet aperture (140) of the collecting tank (100).

In order to be able to replace a drier and filter device (not shown), which can be inserted into the housing (120), the open end (130) of the housing (120) is closed by the removable plug (110), which has a cylindrical shape matched to the shape of the housing. Two sealing rings (200, 210), which are accommodated in circumferential annular grooves (220, 230) in the cylindrical wall (240) of the hollow cylindrical plug (110), serve for sealing. A retainer ring (260), which

prevents the plug (110) from falling out of the aperture (130), is accommodated in an annular groove (250) in the edge of the aperture (130). The working principle of the retainer ring (260) is described in detail in the aforementioned DE 100 39 260 A1, which hereby likewise expressly forms part of the disclosure. Removal of the plug (110) from the housing (120) is facilitated by a screw (now shown), which can be screwed into the blind tapped hole (270), so that the plug (110) can be easily drawn out of the aperture (130).

In order to achieve an improved sealing effect of the sealing rings (200, 210), the plug (110) is made from an elastically deformable plastic, with the result that the plug (110) and in particular the wall (240) thereof is elastically deformable. It should be noted that the deformability of the plug (110) is not so pronounced as to jeopardize the closing action by means of the retainer ring (260).

Whilst the collecting tank (100) is in operation the heat exchange medium present inside the housing (120) thereof is under pressure and from the cavity (280) of the hollow cylindrical plug (110) exerts a force on the inside (290) of the wall (240) of the plug (110). Owing to the elastic deformability of the plug material the wall (240) then bends radially away from the cylinder axis (300) towards the edge of the aperture (130), which in this exemplary embodiment is represented by the tubular wall of the housing (120). As a result the sealing rings (200, 210) in the annular grooves (220, 230) are pressed against the housing (120) and ensure a secure seal. Of essential importance is the fact that the annular grooves (220, 230) with the sealing rings (200, 210) are arranged precisely in an area of the wall (240) on a level with the cavity (280), so that the force generated by the pressure of the heat exchange medium and acting on the

inside (290) of the wall (240) is transmitted sufficiently to the sealing rings (200, 210). In contrast to a cover area (310) of the hollow cylinder, the plug (110) in the area of the wall (240) is relatively thin, in order to further assist this transmission of force.

Even if the wall (240) possibly already bears on the inside of the housing (120) without any internal pressure, the presence of an excess pressure results in increased pressure on the sealing rings (200, 210), since owing to the elastic deformability of the material the plug wall (240) can only partially absorb the aforementioned force, if at all, so that the force acts directly on the sealing rings. An improved sealing effect is therefore possible even under these circumstances.

Overall therefore, larger production tolerances on the dimensions of the housing (120) and the plug (110) are just as acceptable as relative variations in size between the housing (120) and the plug (110) during operation of the collecting tank (100) resulting from different degrees of thermal expansion, which may be caused by temperature fluctuations of the heat exchange medium.